



Developments in Sorbent Injection Technology for Sulfuric Acid Mist Emissions Control

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Sulfuric Acid Mist

A Problem
with
Site-specific
Contributing Factors

That Require
Site-specific
Solutions





Sorbent Injection for Sulfuric Acid Mist Control

Overview

- Problem description
- Consideration of factors contributing to the problem and its solution
 - Combustion
 - SCR
 - AH / ESP / FF
 - General arrangement
 - FGD
- Improved hydrated lime as an SO₃ sorbent
 - Laboratory and pilot development
 - Full-scale demonstrations

Sorbent Injection for Sulfuric Acid Mist Control

The Problem

High sulfur fuel + SCR for NO_x

SO₂ oxidation to SO₃

Increased SO₃ + H₂O → H₂SO₄

10 – 100 ppm SO₃ concentrations

Increased sulfuric acid aerosol formation

Aerosol plume touchdown in surrounding areas



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Contributing Factors - Combustion

- Fuels – coal, coke, oil
 - Sulfur content
 - Metals in ash, especially vanadium, as a source of catalyst
- Combustion and Boiler Operational Parameters
 - Time/temperature profile of boiler
 - Load variation
 - O₂ - oxidation of nitrogen and sulfur
 - Excess air
 - Downstream air in-leakage
 - Magnesia for slag control can provide alkalinity
 - Sootblowing (steam and/or air) for reduced ash catalysis

Contributing Factors – SCR

- **NO_x Reduction Technology - SNCR and/or SCR**
 - Potential for more or less ammonia slip
 - Possible alteration of time/temperature profile
 - Use of economizer bypass
 - Ammonia/urea injection methodology
 - SCR catalyst
 - Type - “normal” or low SO₂ oxidation
 - Changing reactivity over time
 - Non-uniformity of ammonia slip as a source of SO₃ concentration gradients

Contributing Factors – AH / ESP / FF

- Air heater design / operation
 - Temperature, flow, and SO₃ concentration gradients
 - Potential localized sulfuric acid aerosol formation as a function of the flue gas time/temperature profile
- Activated carbon injection for mercury and particulate control technology
 - Differences in control via adsorption or as particulate removal across ESPs or baghouses

Contributing Factors – General Arrangement

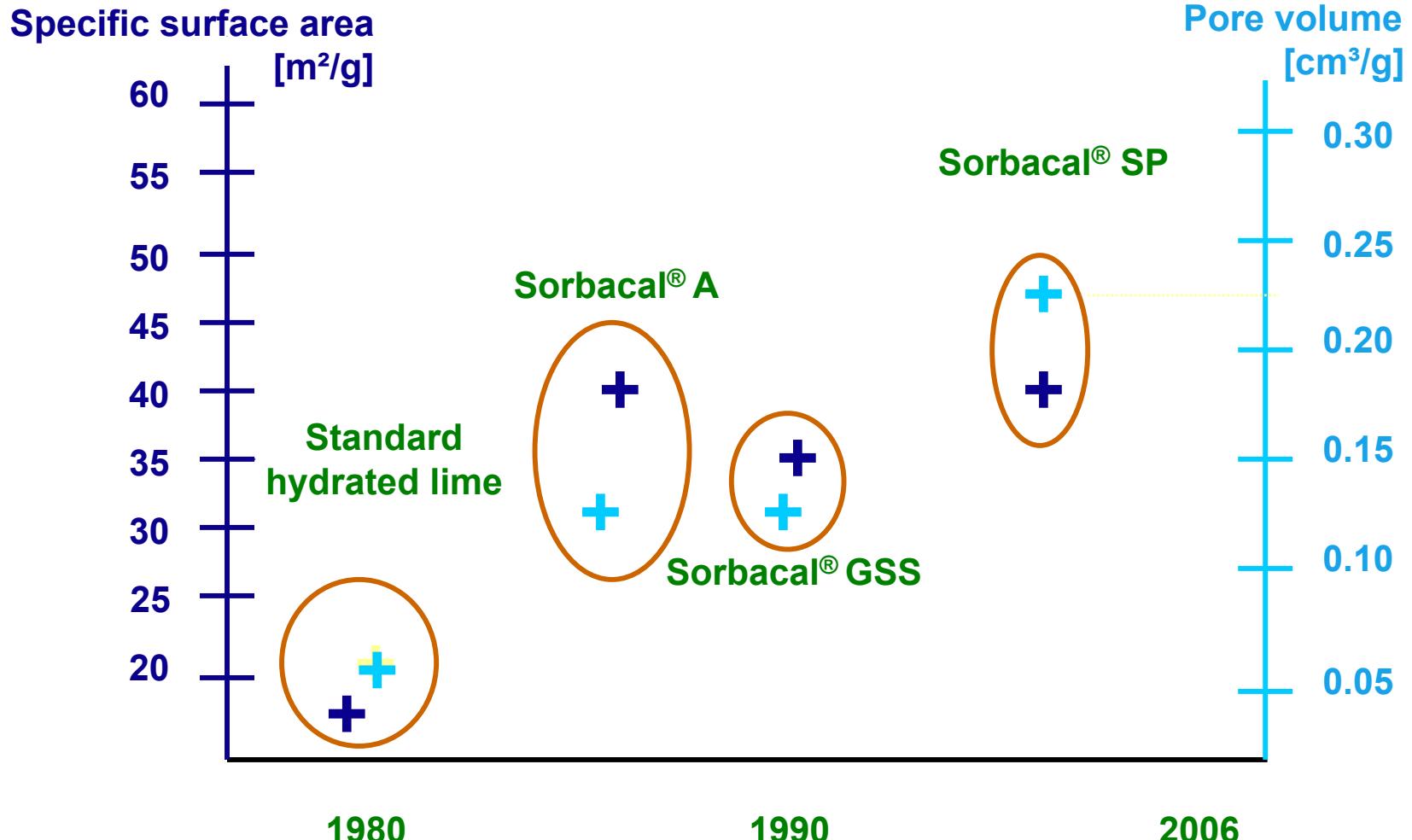
- Equipment type, arrangement and ductwork geometry
- Injection technology options for effective dispersion – lances, nozzles, number and location
- Solids, solutions, slurries
- Residence time effects
- Value of modeling to understand flow, temperature, and concentration profiles
 - Cold flow modeling
 - Computational fluid dynamics (CFD)

Contributing Factors - FGD

- **Dry FGD Technology**
 - Spray Dry Absorbers and Circulating Fluid Bed FGD – effective lime-based SO₃ capture with baghouse
- **Wet FGD Technology**
 - Limited capture of aerosols at typical wet FGD ΔP
 - Some SO₂ capture with residual alkalinity
 - Integral wet ESP – a technology for some applications

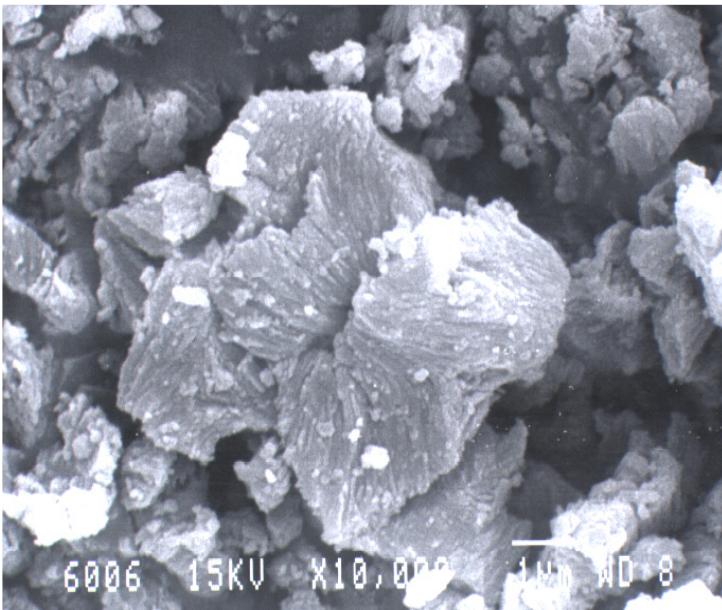
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Development of Hydrated Lime Reactivity

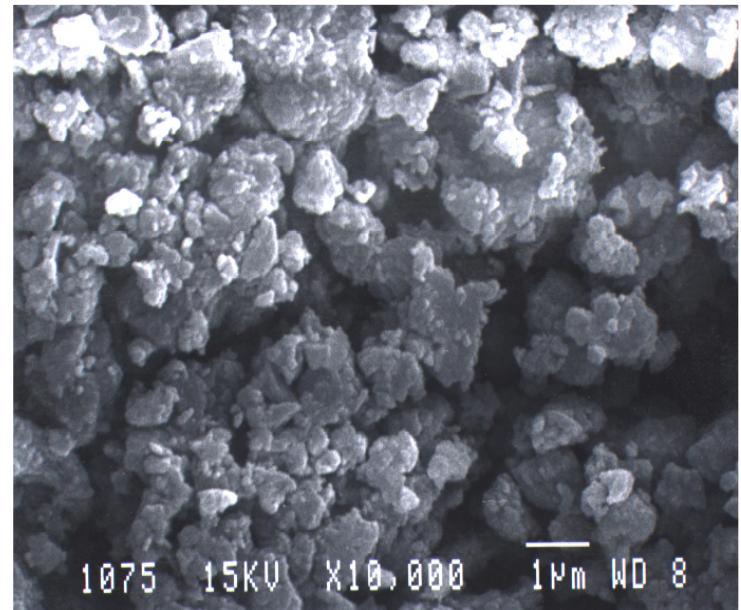


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Reactivity Related to Physicochemical Properties



**Standard
hydrated lime**



**Sorbacal® SP
hydrated lime**

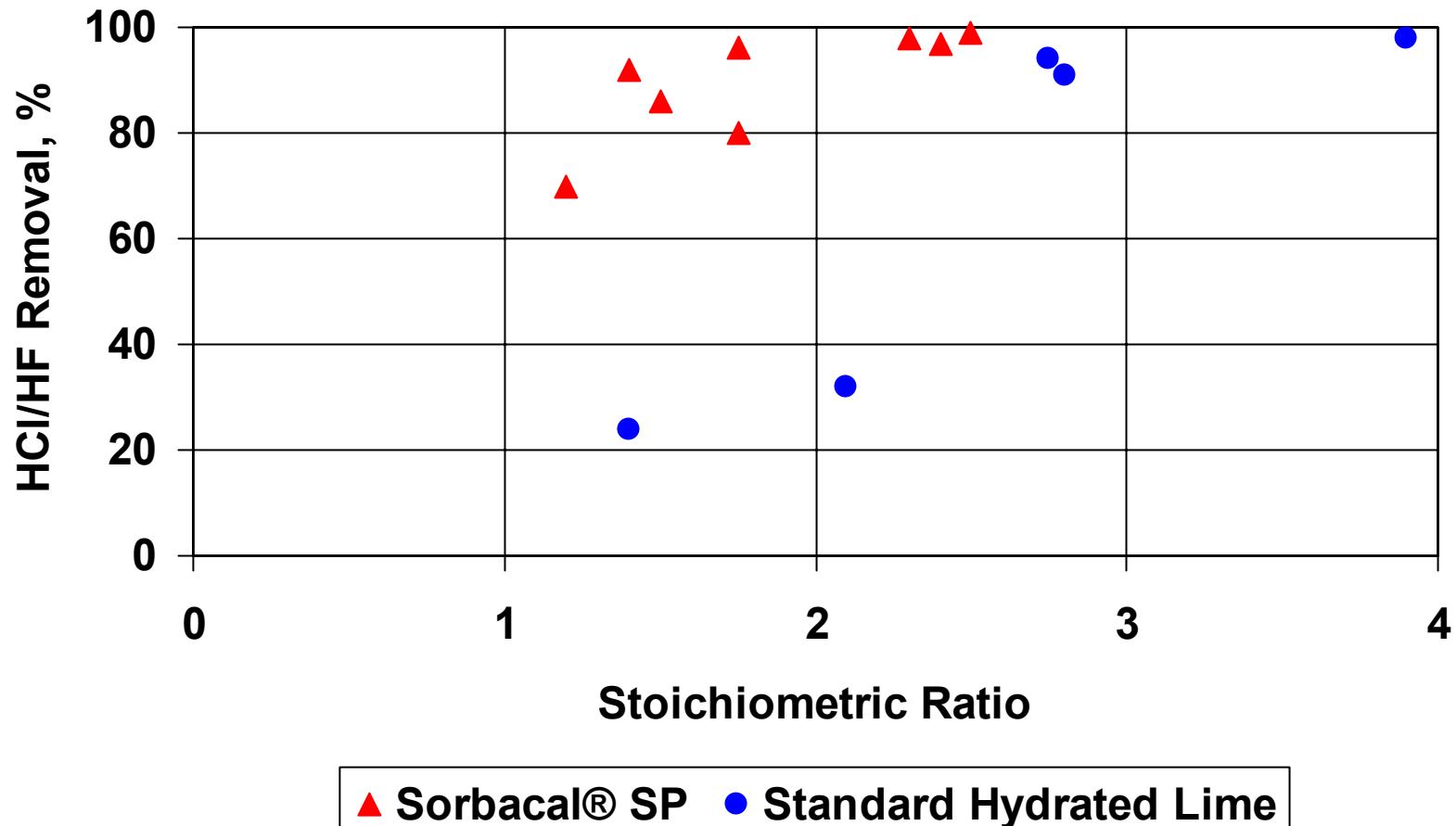
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Lhoist / Rheinkalk Flandersbach Pilot Hydrator (770 lb hydrated lime/hr)



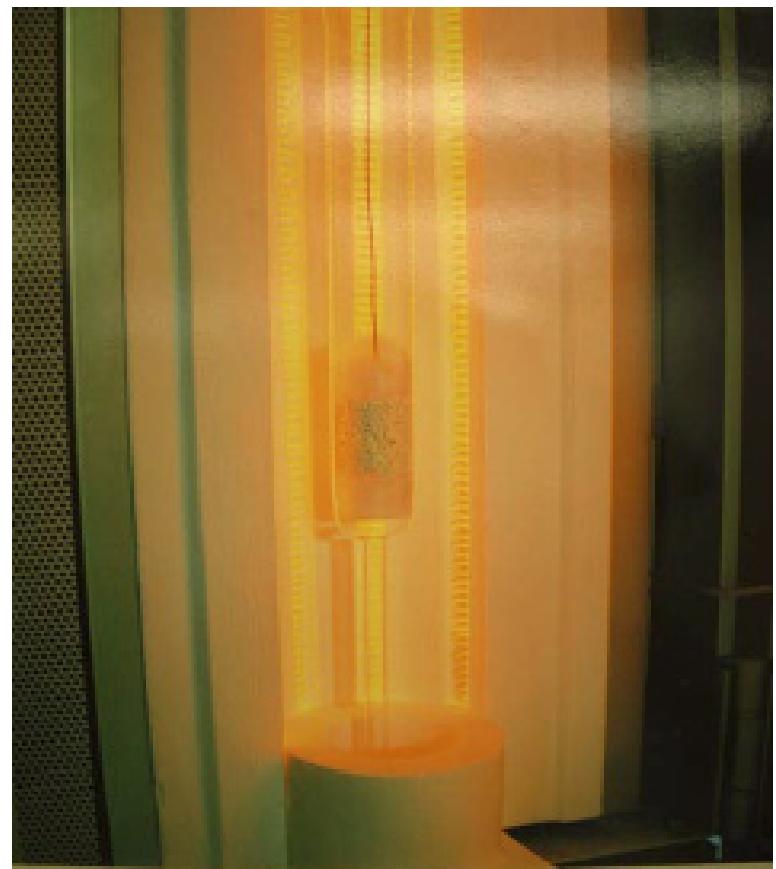
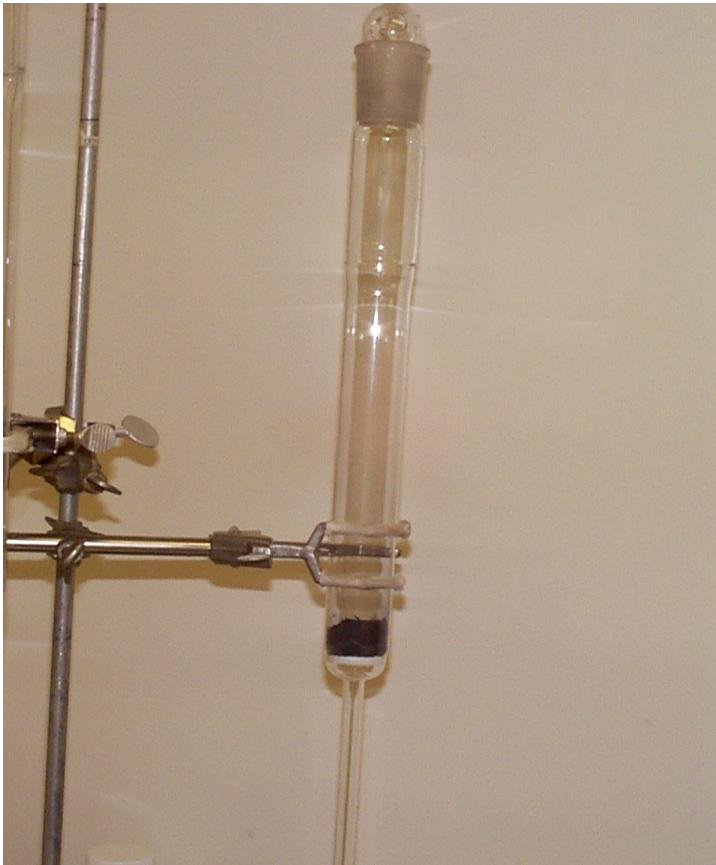
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*Reactivity Improvement Initially Developed
for Municipal Waste Combustors*



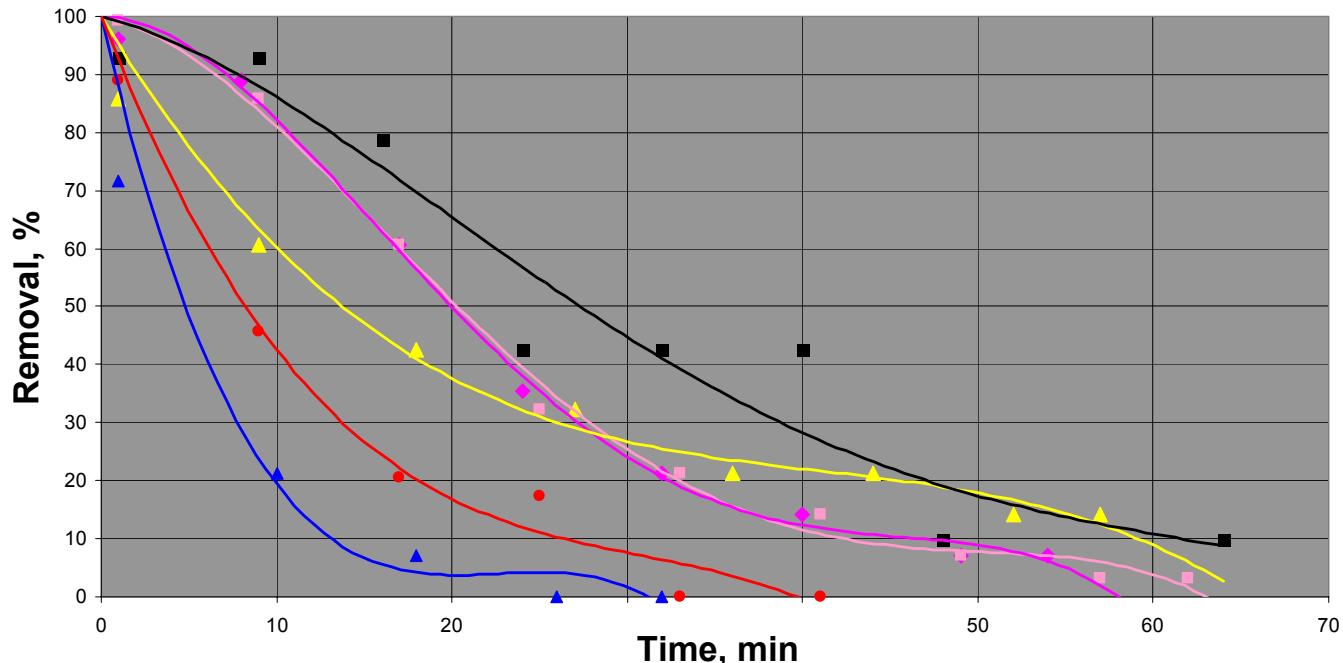
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Fixed Bed Micro-reactor



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Fixed-bed SO₃ Removal



Hydrate A Hydrate B Sorbacal® H Advanced A Advanced B

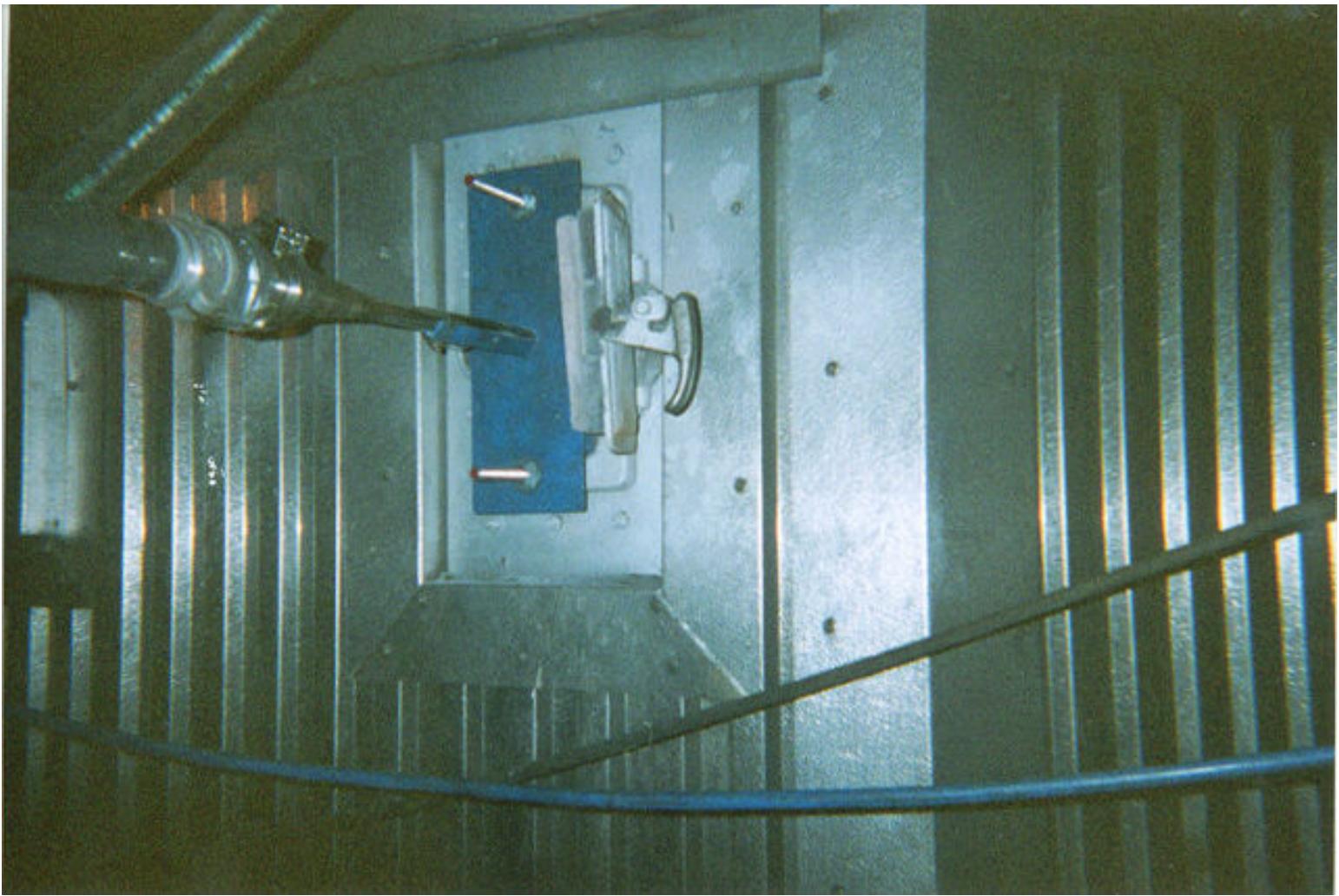
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Hydrated Lime Injection Demonstrations



Sorbent Injection for Sulfuric Acid Mist Control

Typical Hydrated Lime Injection Port



Sorbent Injection for Sulfuric Acid Mist Control

Utility Demonstrations with Sorbacal® H

Hydrated Lime Injection



Without injection

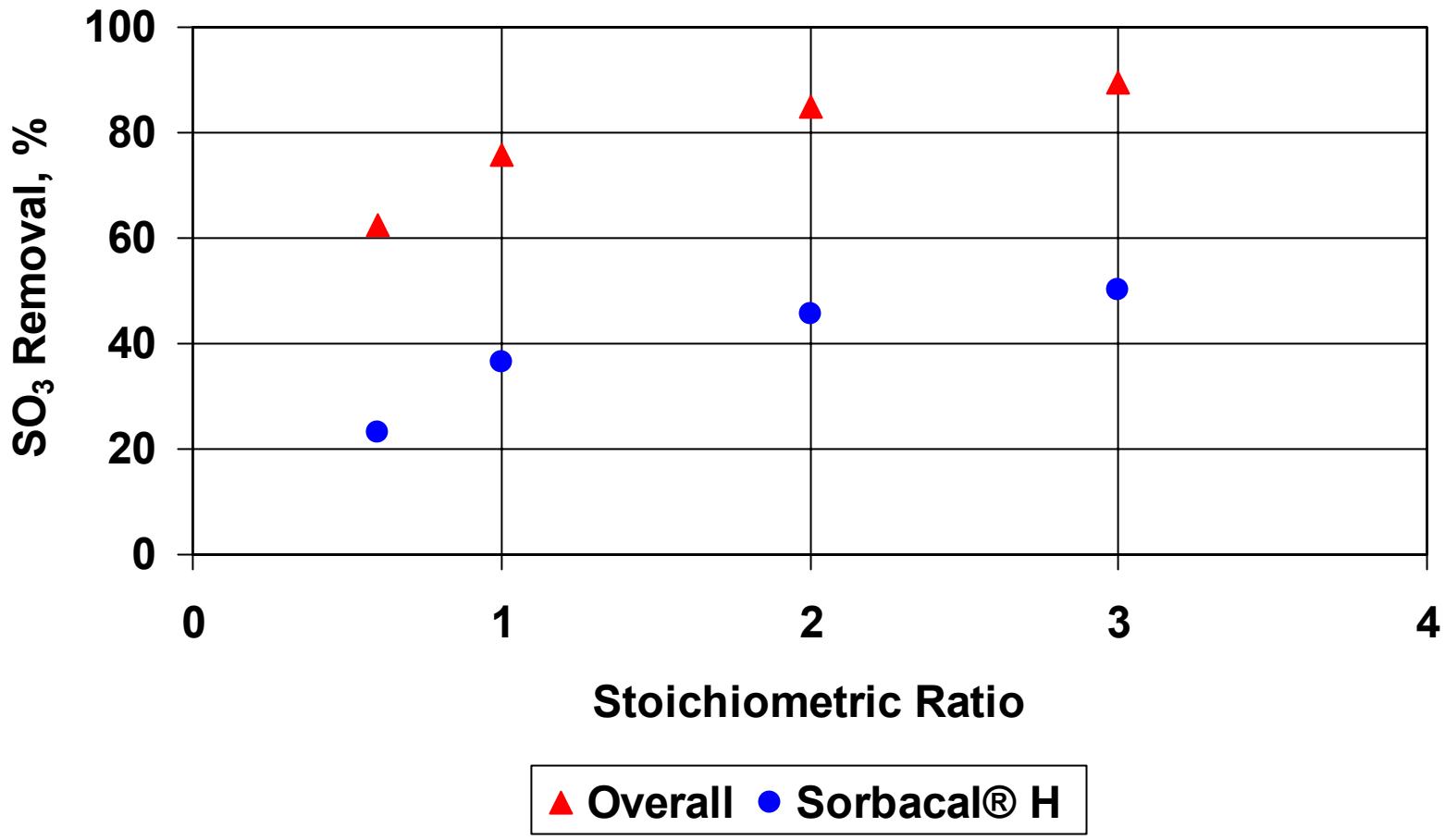


With injection

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SO₃ Removal

*Typical Overall and ~1 sec In-flight Capture
Sorbacal® H Hydrated Lime Injection*



Sorbent Injection for Sulfuric Acid Mist Control

SO₃ Field Demonstrations Conclusions

- Generally 60 to 90 percent overall SO₃ control at Sorbacal® H Ca/SO₃ stoichiometric ratios of 2 to 3
- Typically desired 2 – 10 ppm “outlet” SO₃ concentrations attainable at reasonable sorbent feed rates
- Generally found to be effective for control of acid aerosols to desirable opacity levels
- Ductwork geometry and in-flight residence time found to be important practical factors

Continuing Development Activities

- Further examination of manufacturing techniques that influence hydrate physicochemical properties
- Studies on additives for hydrated lime related to reactivity toward acid gases
- Full-scale comparison of hydrated limes found to be more reactive than Sorbacal® H

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Thank You

